

EXHIBIT D

IPR2021-00178
PATENT NO. 8,407,273

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GOOGLE LLC,
Petitioner,

v.

SINGULAR COMPUTING LLC,
Patent Owner.

Patent No. 8,407,273
Filing Date: February 17, 2012
Issue Date: March 26, 2013
8,407,273
Inventor: Joseph Bates
Title: PROCESSING WITH COMPACT ARITHMETIC
PROCESSING ELEMENT

DECLARATION OF SUNIL P KHATRI, Ph.D.

Case No. IPR2021-00178

36. The ‘273 Patent is directed in general to the field of computing, and more specifically addresses the ability to compute rapidly, which is of key importance to several areas such as weather and climate prediction, medical applications, national defense, geological exploration, and several other applications that depend on the ability to perform massive amounts of calculation. ‘273 Patent at 1:27-35. Computing is a highly predictable art based on known mathematical concepts.

37. The ’273 Patent claims a particular device implemented using transistors, which are also called Field Effect Transistors or FETs. ‘273 Patent, 1:52-53, 1:61-2:7, 3:7-10, 3:19-22, 3:23-28, 4:49-52, 5:6-10, 5:38-55, 6:24-50, 7:12-39, 10:42-45. These are commonly implemented on silicon. ‘273 Patent, 1:52-53, 1:61-65, 3:53-56, 6:30-32, 5:41-43, 6:16-19, 13:11-15, 24:65-25:4, 25:53-56, 26:5-7, 26:17-20, 28:40-52. The ‘273 Patent teaches LPHDR execution units with a specific dynamic range and precision.

38. One of the main benefits of the technology taught in the ’273 Patent is that it allows for larger numbers of LPHDR execution units to be implemented in the same amount of space or transistors as a smaller number of full precision units (‘273 Patent, 2:20-27). Because an LPHDR execution unit is simpler than a traditional full precision unit, “embodiments of the present invention may be implemented as any kind of machine which uses LPHDR arithmetic processing

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elements to provide computing using a small amount of resources (e.g., transistors or volume) compared with traditional architectures.” ’273 Patent at 8:3-7.

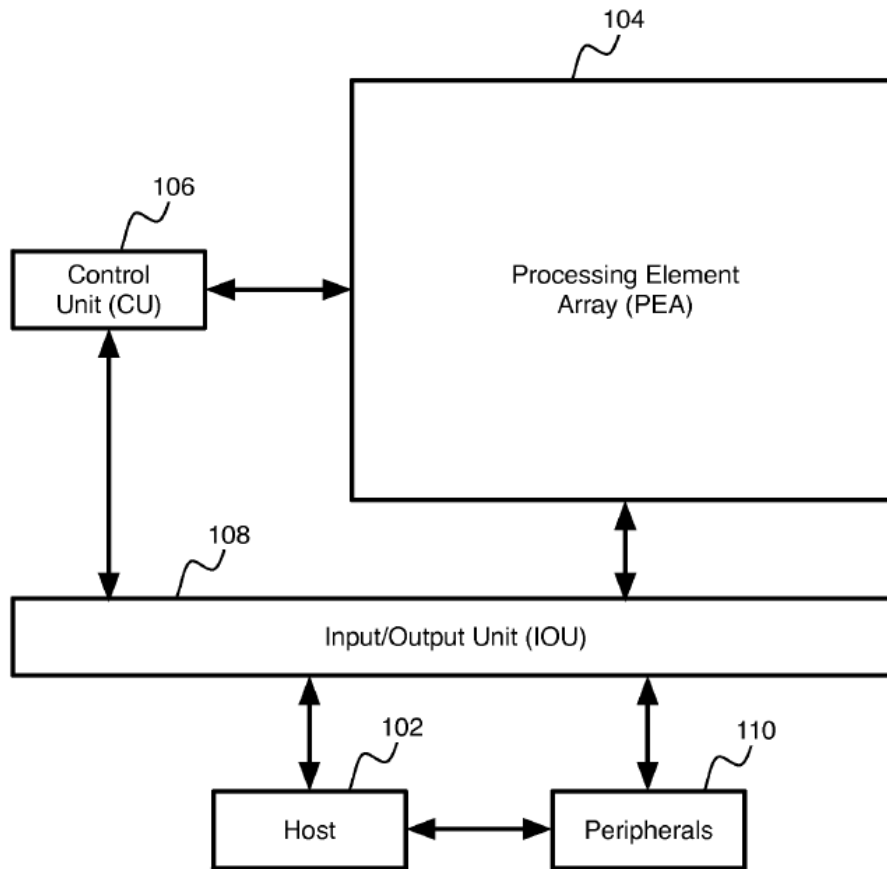
39. The invention can be implemented using a variety of technologies. The underlying technology, whether traditional silicon transistors or otherwise, is not the invention. Indeed, the invention is agnostic to the types of underlying physical technologies used to build it.

G. The ’201 Application’s Disclosure Fully Supports The Claims

40. I understand that Petitioner argues that U.S. Patent Appl. 12/816,201 (Ex. 1005, “the ’201 Application”) does not provide written description or enablement support for the Challenged Claims of the ’273 Patent. I disagree.

41. The ’201 Application includes a detailed example implementation of the invention implemented using transistors. ’201 Application, [0042-64].

42. Figure 1 shows a high-level description of the example:



'201 Application, Figure 1

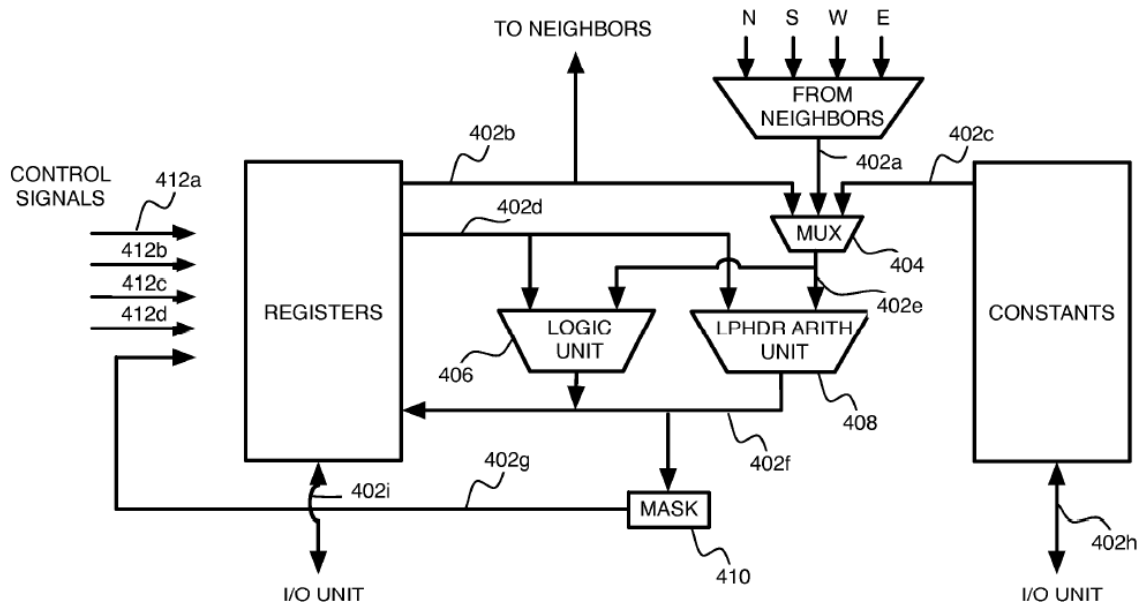
43. Broadly speaking, the example includes a Processing Element Array (PEA) composed of a plurality of processing elements/LPHDR execution units,¹ a

¹ The '201 Application often uses the term “processing element” which is a “kind of execution unit.” '201 Application at [0042-43]. In my opinion, one of skill in the art would understand that “processing element” can be used interchangeably with “execution unit” in the '201 Application and the '156 Patent. I understand that Petitioner agrees with me. Pet. at 51-52.

control unit (CU), an input/output unit (IOU), as well as a host and peripherals.

'201 Application at [0043-50].

44. The '201 Application further describes an example implementation of one of the PEs, which contains an LPHDR execution unit, and is in turn contained in the PEA. '201 Application at [0054-65]. Figure 4 shows the arrangement of components:



'201 Application, Figure 4

45. The execution unit stores its data locally in the Registers and Constants circuits. *Id.* at [0054]. The data paths 402 and routing mechanisms, such as MUX 404, allows data to flow to the Logic Unit 406 and LPHDR Arithmetic Unit 408. *Id.* at [0055]. The Logic Unit and LPHDR Arithmetic Unit perform the logical or LPHDR arithmetic operations on the data respectively.

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50. The '201 application further describes how to realize the LNS based LPHDR arithmetic unit ('201 application, FIG. 6, 67-72).

51. As discussed above, the '201 Application further describes the computing device that controls the operation of the LPHDR execution units. *See, e.g.,* '201 Application at Fig. 1.

52. In my opinion, the '201 Application thus describes the full invention claimed in the '273 Patent and teaches one of skill in the art how to realize it. A person of skill in the art would understand, as I set forth above, that the inventor had full possession of the invention.

53. I understand that Petitioner has argued that the claims cover implementations that utilize components other than traditional silicon transistors. Pet. at 17-20. Even if the claims covered such an implementation, a person of skill in the art would still understand the invention and that the inventor had full possession of it.

54. As explained in more detail below, each of the technologies that Petitioner identifies, in 2010, had existing designs for transistors or similar switching functionality. In fact, in the field of computing, alternate switching technologies are always studied and described in terms of their switching behavior, just like transistors. In my opinion, a person of skill in the art would have had no difficulty translating the silicon transistor implementation set forth in the '201

Application to any other technology that was able to implement devices (like transistors) that can act as switches.

55. In my opinion, all that is required to implement the invention is an underlying technology that can provide arithmetic operations on signals that represent values. The most well-known way to implement arithmetic operations is via transistors or transistor-like functionality. As I discuss more below, in 2010, performing arithmetic operations on each of the so-called species of representations that Petitioner identifies were well-known.

56. Petitioner has argued that the '201 Application does not support a non-deterministic analog implementation of an execution unit. Pet. at 19. I disagree. The example embodiment described in the '201 Application can be implemented using analog circuits (on any type of representation, as described below). Moreover, the example embodiment achieves an error of 1-2%, more than the claimed error amount of 0.05% or 0.2%; the introduction of additional uncertainty by using analog components would only increase the error or leave it unchanged.

57. I understand that Petitioner has argued that the '201 Application does not support the claims of the '273 Patent because, according to Petitioner, the claims are not limited to any particular numerical representation. Pet. at 19-20. I disagree. In my opinion, the numerical representation is not relevant to the

invention. The LPHDR execution unit of the '273 Patent claims is agnostic to the numerical representation used to realize it. The invention can be implemented, using the principles discussed and the example embodiment, in other numerical representations as well, such as fixed point, floating point, or logarithmic ('201 Application at [0134]). Arithmetic operations on different numerical representations, such as fixed point, floating point, or logarithmic were well-known in the art in 2010. A POSA would know this from a basic class in digital logic circuits typically taught in the sophomore year in an undergraduate ECE curriculum.

58. Similarly, even if the claims cover different physical representations, such as charges, voltages, various forms of spikes, or other forms, or a combination of digital and analog representations (Pet. at 19-20), those representations are not relevant to the invention. The LPHDR execution unit of the '273 Patent claims is agnostic to the physical representations used to realize it. The invention, as I explain above, is about performing LPHDR arithmetic on the numbers represented by those voltages, etc.

59. Indeed, in 2010, operating on numbers stored as charges, currents, voltages, frequencies, pulse widths, pulse densities, various forms of spikes, or other forms was well-known. Charges are used to represent numbers in all modern computers and have been for decades. Exemplary references show how to perform

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Executed this 24th Day of February, 2021

Respectfully submitted,



Sunil P Khatri, Ph.D.